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PATTERNS OF HIERARCHY IN FORMAL AND PRINCIPLED MORAL REASONING

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ABSTRACT

Measurements of formal reasoning and principled moral reasoning ability were obtained from a sample of 99 tenth grade students. Specific modes of formal reasoning (proportional reasoning, controlling variables, probabilistic, correlational and combinatorial reasoning) were first examined. Findings support the notion of hierarchical relationships which exist among those variables. Further results from factor analysis provide evidence that the variables represent specific cognitive structures that are interdependent with each other and precede operations in development. Finally, significant relationships were found to exist between the different modes of formal reasoning and principled moral reasoning. Combinatorial and correlational reasoning were found to significantly account for 22 percent of the variance in principled moral reasoning. Theoretical and educational implications were discussed.

INTRODUCTION AND PURPOSE

The central role of cognitive development and its relationship to other areas of life span development have captured and held the interest of researchers and educators particularly over the last decade (Tomlinson-Keasey and Keasey 1974; Kohlberg, 1976; Kuhn et. al. 1977; Karplus et. al. 1980). In terms of moral development, a general correspondence between cognitive operations and moral stage level has clearly been developed. Cognitive development is understood to be a necessary but not sufficient condition for moral development. Moral development occurs along a parallel path in juxtaposition with, but theoretically distinct from cognitive development (Kohlberg and DeVries 1969; Keasey and Keasey 1974; Colby and Kohlberg 1975; Kuhn et. al. 1977).

Much of the past developmental research, however, had been burdened with assessment instruments or tasks which were relatively novel and subsequently restrictive in terms of their generalization because of a lack of reliability information. Kuhn et. al. (1977) noted that much of the empirically observed variability in many of the assesment techniques used to assess cognitive and moral operations was due to unreliability in the instruments used to tap those constructs

> As we learn more about the exact nature of cognitive operations involved in each of the stage sequences and develop more precise means of assessing these operations, it may turn out that the developments which occur in each of the domains (cognitive and moral) are in fact more closely related than our present data indicate (p. 179).

Tomlinson-Keasey and Keasey (1974) also studied the mediating role of cognitive operations on moral reasoning and suggested evidence for the centrality of logical operations. But again, because of the restrictive assessment techniques they were limited to abserving relationships between the two domains at the operatory level. Keasey and Keasey did have the foresight to suggest the possibility that:

> ...an ability acquired during formal operations, such as the consideration of all the possibilities, would help a child to think of answers other than conventional ones when faced with a moral dilemma (p. 297, 1974).

Fortunately, the tenacity of educational researchers has led to the refinement of instruments which have undergone substantial validity and reliability construction. Most notably, Tobin and Capie (1980a, 1980b, 1981) have extended the work of Lawson (1978) and Lawson et. al. (1979) to develop an objective group test of logical reasoning ability. The instrument is called the Test of Logical Thinking (TOLT) and is a measure of five different modes of formal reasoning: proportional reasoning, the ability to control variables; probabilistic reasoning; correlational reasoning and combinational reasoning. Advances have also been made in the realm of moral stage assessment. Rest (1976, 1979) has constructed an objective measure of moral reasoning called the Defining Issues Test (DIT) which is consistent with Kohlberg's stage theory of moral development and yields a value for the percentage of postconventional (principled) moral reasoning employed by subjects.

The implications of the advances made in recent test development open up numerous possibilities for researchers to investigate. For example, some researchers (Inhelder and Piaget, 1958; Adi et. al. 1978) have theorized that proportional and probabilistic reasoning are prerequisites of correlational reasoning. McKenzie and Padilla (1982) tested this proposed hierarchy using TOLT, but their results were inconclusive. However, their sample consisted of subjects ranging from grades six through twelve, with over 60% of them in grades six through eight. It might be the case that such a wide range of developmental differences with many subjects in transitional stages masked the effects of the proposed hierarchy.

Therefore, one aim of the present study was to replicate a part of McKenzie and Padilla's (1982) study, using subjects from one grade level (tenth grade). There is evidence which suggests that individuals have the ability to use their formal reasoning skills somewhat more consistently at the tenth grade level than earlier grades in which students are apt to be transitional (Karplus et. al. 1980). Another implication of the TOLT is that it provides one with the opportunity to investiage with some degree of confidence specific features of cognitive thought. The second aim of the present study was to formulate evidence from the results of the TOLT which support the existence of singular cognitive structures which together construct more encompassing operations. The third aim of the present study was to more precisely document the relationship between formal operations and postconventional reasoning. While it has been revealed that individuals express a range of principled moral reasoning, depending on the context of the moral problem and the experiences that a person has had with the

content embedded in a problem (Lozzi 1976; Zeidler & Schafer 1984), the role of specific formal reasoning skills on principled moral reasoning has yet to be examined. Identifying specific cognitive structures which appear to influence moral reasoning would be of instrumental value to educators in narrowing the decalage that exists between the two domains.

METHOD

Subjects

The subjects were selected from a sample of tenth grade biology students from a high school located in a middle to upper-middle class suburban community of Delaware. Of the 99 students from which complete information was obtained, 43 were male and 56 were female. There were 71 white students and 28 black students in the sample. The mean age of the entire sample was 15.6 years.

Tests

Test of Logical Thinking

The Test of Logical Thinking (TOLT) was developed by Tobin and Capie (1980a, 1980b, 1981) for the purpose of assessing formal reasoning skills in an objective, group test format. Questions included on the TOLT represent items that have been demonstrated to tap formal operations (Lawson, 1978, Lawson et. al. 1979) and be consistent with the research on cognitive development by Inhelder and Piaget (1958, 1975). The test consists of ten items which measure five different modes of formal reasoning ability; proportional reasoning, controlling variables, probalistic reasoning, correlational reasoning, and combinatorial reasoning. The TOLT requires individuals to solve problems in each of the above areas, select a correct response, and choose the best explanation for their response. Tobin and Capie (1981)

report criterion-related validity of the TOLT with performance on interviews assessing the same logical reasoning skills as a ,80 correlation. The authors also report highly significant predictive validity (p= .0001) of the TOLT with several measures of achievement and intellectual development (e.g.: Integrated Process Skills, SAT, Paper Folding and Surface Development Tests). A one factor solution of individual items on the TOLT provided support for construct validity. Reliability as measured by Cronback's alpha for internal consistency was found to be .85 (n=682).

Defining Issues Test

The Defining Issues Test (DIT) is a measure of moral reasoning on general social problems. The test consists of stories which present social dilemmas. Each dilemma is accompanied by issue statements which reflect different levels of moral judgment. The subjects rank these statements according to perceived importance. The test is considered to be objective and consistent with Kohlberg's stage theory of moral development (Rest, 1976; 1979). Rest reports highly significant criterion group validity with 50% of the variance in test scores attributed to group differentiation. He also found significant (p= .0001) longitudinal change validity in both cohort and time-sequential designs. Convergent-divergent validity, validation of internal structure and validation through experimental enhancement studies have also been well establish and published elsewhere (Rest 1979, 1979a). Davidson and Robbins (1978) report test-retest reliability of .80 and Cronback's alpha (internal consistency) index in the upper .70's.

Procedure

Consent was obtained from all potential subjects, and instructions concerning the directions of each test were given to the subjects prior to the day of testing. Consequently, the subjects had ample time during the course of their class period to complete one instrument. Subjects were arranged at opposite ends of lab tables (a procedure they were familiar with during normal class testing) and remained quiet for the duration of the period. Subjects responded to the DIT on the first test date, and then to the TOLT two days later. Listwise deletion was employed on subsequent data analyses so that computations were derived from the same set of data. Complete information was obtained from 99 students.

RESULTS AND DISCUSSION

Patterns of Hierarchy in Formal Reasoning

To test the proposed theoretical cognitive hierarchy (proportional and probalistic reasoning are necessary determinants of correlational reasoning) reviewed above, subject's response patterns were analyzed in a manner that was consistent with McKenzie and Padilla's (1982) study. Positive (+) marks indicate success while negative (-) marks indicate failure on a particular mode of formal reasoning. A subject had to demonstrate success on at least one of the two problems for a given mode of reasoning in order to be assigned a positive mark. Table 1 is presented in two sections, combinations of patterns which support the hierarchy and those which

negate it. The percentages are based upon 93 subjects (rather than 99) since six subjects yielded negative marks on all three variables; a pattern which neither supports or negates the proposed hierarchy.

(INSERT TABLE 1 HERE)

The results of Table 1 provide support for the proposed hierarcy; that the attainment of proportional and probabilistic reasoning skills contribute to success on correlational reasoning ability at the tenth grade age level. In total, 65.5% of the subjects response patterns supported the hierarchy, while 34.5% negated it. Those results are different from McKenzie and Pidilla's (1982) study in which only 44.8% of the subjects yielded response patters which support the hierarchy. However, the differences found between the two studies may be attributed to a wider range of developmental differences in the subjects of each study. Since over 60% of the subjects in McKenzie and Pidilla's (1982) study were from grades six through eight, it is possible that many of them were in transitional points of development where inconsistencies in reasoning patterns are not uncommon. Additional support for this argument may be found from the response frequencies on proportional, probability and correlation problems analyzed by Karplus et. al. (1980) in which substantial fluctuations in performance were observed in transitional subjects (between concrete and formal operations) from grades six through ten.

Evidence for Cognitive Structures

Factor analytic studies involving the TOLT have been conducted by other researches (Tobin and Capie, 1981; Padilla et. al. (1983)

for the purpose of establishing construct validity. There is consenses that the items of the TOLT tap a common underlying construct (formal reasoning) by virtue of the fact that single factor solutions were obtained with relatively high correlations between each mode of reasoning and the factor. There are however, more subtle inferences that may be drawn if the results of the factor analyses are examined further.

Since factor analyses provides communality estimates (h^2) which represent the variance that a particular variable has in common with one or more of the remaining variables of that factor, $1-h^2$ represents that portion of the variance that is unique to that variable (Rummel, 1967). The unique component of the variable may be further decomposed into an error term, and the specific component of the variable (Harman, 1976). The specific component is called the specificity of the variable and shows the portion of the variable that is not due to random error; or the portion of the variable's observed variance that is due to a factor specific to that variable (Kim and Mueller 1978). It is within that specific component of each variable where evidence may be found which suggests that the five modes of formal reasoning represent something more specific than one overall operation; viz.,distinct interdependent cognitive structures.

Principle axis factor analyses was used employing the Kaiser (1960) criterion in order to replicate Tobin and Capie's (1981) procedures on the five formal reasoning variables. In addition, the uniqueness and specificity values for each variable were derived from the communality estimates following Harman's (1978, pp. 18-21) procedures. Table 2 shows the results of that analysis.

(INSERT TABLE 2 HERE)

The factor structure loadings and communality values add support to the validity of Tobin and Capie's (1981) findings; the five variables do represent one underlying cognitive construct (formal reasoning). Furthermore, the specifity values for each variable add empirical support for the existence of more rudimentary, singular cognitive structures which Piaget et. al. (1977) and Inhelder and Piaget (1964) theorized to develop in parallel stages. Such structures precede operations; develop in mutual dependence of each other, and when combined, represent the full expression of an operation.

Formal Operations and Principled Moral Reasoning

Stepwise multiple regression was performed to determine to what extent specific modes of formal reasoning account for variance in postconventional moral reasoning at the tenth grade age level. Table 3 displays the correlation coefficients obtained prior to the analysis. Table 4 shows the results of the regression analysis.

(INSERT TABLE 3 HERE)

(INSERT TABLE 4 HERE)

It should be noted that the correlation of the TOLT with the DIT in Table 3 was highly significant (42.6, p= .0001). This finding is consistent with present developmental theory; that a linkage exists between the two distinct domains of cognitive and moral reasoning. While the general correspondence between the two domains has been established (see introduction), the development of

the TOLT and DIT now made it possible to examine what specific cognitive structures contributed to moral reasoning. It was found that combinatorial and correlational reasoning accounted for 22 percent of the variance of principled moral reasoning (p= .001). Controlling variables, proportional and probabilistic reasoning did not significantly contribute to moral reasoning. It is possible for the variables selected into the equation to change across samples with different developmental characteristics. Perhaps other variables would take on new importance with older subjects.

Scores of 4 or higher on the TOLT are considered to represent those which may be classified as "formal thinkers" (Padilla et. al. 1983). The mean for the tenth grade student's TOLT score was 5.1 (SD = 3.1; standard error of measurement = .31). (Note: The mean for the DIT scores was 17.9; SD = 6.8; standard error of measurement .73). Therefore, it would appear that the middle high school years represent the point of consolidation of early formal cognitive structures which are related to the emergence of principled moral reasoning. This latter point supports the hypotheses of Inhelder and Sinclair (1969) and Kuhn et. al. (1977) which view logical operations as a "processing mechanism" central to other areas of development. (e.g.; moral development).

The fact that combinational reasoning and correlational reasoning were found to significantly account for variance in principled moral reasoning adds empirically to our understanding of the cognitive prerequisites that are necessary for the utilization of moral judgement. For eample, Kohlberg (1973b) stated that part of postconventional

reasoning is the ability of an individual to arrive at a decision having sought knowledge of all competing claims facts and interests, to understand the correlative nature of rights and duties, and to apply reversibility in order to consider all possibilities as a criterion of fairness for a moral decision. The present research indicates that combinatorial and correlational reasoning are indeed instrumental in the principled reasoning process.

IMPLICATIONS

The results of this study have emphasized the developmental importance that formal reasoning skills have on the individual. It would appear to be pedagogically wise for teachers to stress proportional and probabilistic reasoning skills before students are expected to solve or understand problems involving correlational reasoning. This would promote more consistent reasoning patterns on behalf of the students.

The specificity values derived from the factor analysis of the TOLT items provided evidence for the existence of singular, interdependent cognitive structures. This finding suggests that students do not simply apply one set of formal operations to different problems; rather they apply different interdependent structures to solve different kinds of problems. This distinction is of theoretical importance in terms of understanding how individuals come to construct knowledge from experience. Hence, teachers should not necessarily expect that a student who exhibits good combinatorial reasoning skills can then

simply apply those same skills to solving other abstract tasks. It appears to be the case that each mode of formal reasoning as measured by the TOLT possess fundamentally different and unique cognitive attributes.

Finally, the relationship between the student's scores on the TOLT and DIT is important to consider. The students in this study could be classified as "formal thinkers" as a group, and yet this group displayed only 18 percent usage of principled stages of moral reasoning. This would suggest that the consolidation of early formal structures is needed before students can be expected to employ principled moral reasoning. Teachers who attempt to promote moral development in the classroom by discussing various ethical issues should not presume that formal thinkers will necessarily use reasoning on problems at the principled level. However, since combinatorial and correlational reasoning were important predictors of principled moral reasoning, teachers should stress the importance of those cognitive skills in the realm of solving social problems.

LIMITATIONS OF STUDY

In most studies, there exists a realistic trade-off between theoretical integrity and practical implementation of the study. One aim of the present study was to see if more interpretable results could be obtained to support the proposed hierarchy by using subjects from one grade level (rather than combined grade levels which were analyzed as one group in McKenzie and Padilla's (1982) study). An improvement of the present study would be to collect data on several grade levels with larger sample sizes and observe any development differences which may exist across various age levels. Arrangements

with the public school system in Delaware have been made and data collection is in progress. The following study will attempt to broaden our understanding of the interrelationship which exist among cognitive structure and the role they play in moral reasoning.

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TABLE 1

Combinations of Subject's Responses which Support and Negate that Proportional and Probabilistic Logic are Necessary Prerequisites for Correlational Logic (n=93)

Proportions	Probability	Correlations	Percent Supporting Hierarchy
-	+	-	8.6
+	-	-	10.7
+	+	-	8.6
+	+	+	37.6
		Total	65.5
			Percent Negating Hierachy
-	-	+	11.8
-	+	+	11.8
+	-	+	10.7
		Total	34.5

TABLE 2

Factor Structure Loading, Communality, Uniqueness and Specificity of Hypothesized Cognitive Constructs

Modes of Reasoning (Hypothesized Structures)	Factor 1 Structure Loading	Communality (h^2)	Unique Component (uj^2)	Specific Component (bj^2)
Proportional Reasoning	.62	.39	.61	.43
Controlling Variables	.66	.43	.57	.39
Probabilistic Reasoning	.62	.39	.61	.22
Correlational Reasoning	.61	.38	.62	.18
Combinatorial Reasoning	.63	.39	.61	.32

(Eigenvalue = 1.98; n=99)

TABLE 3

Pearson Correlation Coefficients Between Postconventional Moral Reasoning and Formal Reasoning Variables (n=80)

	Formal Reasoning Variables					
	Proportional Reasoning	Controlling Variables	Probabilistic Reasoning	Correlational Reasoning	Combinatorial Reasoning	TOLT
Postconventional Moral Reasoning	23.2	31.5	19.5	39.2	39.6	42.6
	p=.01	p=.002	p=.04	p=.0001	p=.0001	p=.0001

TABLE 4

Stepwise Multiple Regression for Formal Reasoning Variables on Postconventional Moral Reasoning

Step	Variable	R^2	FOBS (to enter)	DF	BETA	FOBS (Full Model)
1	Combinatorial Reasoning	15.7	14.5**	(1,78)	.396	14.5**
2	Correlational Reasoning	22.0	6.2*	(2,77)	.275	10.8**

* $p < .005$

** $p < .001$